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| APPLICATION NO.   | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/074,128  | 02/12/2002  | Christopher A. Bower | BOWER 8-218-62      | 8161             |
| 7590 03/10/2004   |             |                      | EXAMINER            |                  |
| LOWENSTEIN SANDLER PC<br>65 LIVINGSTON AVENUE<br>ROSELAND, NJ 07068 |             |                      | MARKHAM, WESLEY D   |                  |
|   |             |                      | ART UNIT            | PAPER NUMBER     |
|   |             |                      | 1762                |                  |
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Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/074,128

Applicant(s)

BOWER ET AL.

ed

Examiner

Wesley D Markham

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-27 is/are pending in the application.
- 4a) Of the above claim(s) 25-27 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 24 April 2002 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date ____. | 6) <input type="checkbox"/> Other: ____.  |

## **DETAILED ACTION**

### ***Election/Restrictions***

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1 – 24, drawn to a process for fabricating an article comprising at least one elongated nanostructure, classified in class 427, subclass 577.
  - II. Claims 25 – 27, drawn to an article comprising an elongated nanostructure, classified in class 428, subclass 369.
2. The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process of making and product made, respectively. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case, the product as claimed can be made by another and materially different process, such as (1) a process in which the elongated nanostructures are grown in the absence of a catalyst metal, (2) a process in which the elongated nanostructures are grown directly on metal catalyst particles (i.e., not on a substrate having a surface including one or more regions of catalyst metal), or (3) a process in which straight nanostructures and curly nanostructures are grown separately and subsequently bonded, attached, or connected to each other in the desired sequence.
3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification and

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recognized divergent subject matter, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Mr. Glen Books on 3/1/2004, a provisional election was made without traverse to prosecute the invention of Group I, Claims 1 – 24. Affirmation of this election must be made by applicant in replying to this Office Action. Claims 25 – 27 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.
5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

#### ***Priority***

6. Applicant has not complied with one or more conditions for receiving the benefit of an earlier filing date under 35 U.S.C. 120 as follows: The later-filed application (10/074,128) must be an application for a patent for an invention which is also disclosed in the prior application (the parent or original nonprovisional application or provisional application – 09/512,873); the disclosure of the invention in the parent application and in the later-filed application must be sufficient to comply with the requirements of the first paragraph of 35 U.S.C. 112. See *Transco Products, Inc. v. Performance Contracting, Inc.*, 38 F.3d 551, 32 USPQ2d 1077 (Fed. Cir. 1994). In

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the instant, later-filed application, independent Claim 1 (from which Claims 2 – 24 depend) requires, in part, “growing on said one or more regions at least one elongated nanostructure having at least one substantially straight region and at least one curly defect region, the straight region grown under the influence of an electrical field and the curly defect region grown with the field off.” After a thorough review of parent application 09/512,873, the examiner notes that the aforementioned claim limitation is not disclosed, described, or suggested in the parent application.

Therefore, the instant, later-filed application is not an application for a patent for an invention disclosed in the prior application, and the disclosure of the parent application is not sufficient to comply with the requirements of the first paragraph of 35 U.S.C. 112. As such, the effective filing date of Claims 1 – 24 of the instant application is 2/12/2002 (i.e., the filing date of the instant application), even though a significant portion of the disclosure of the instant application (which is a CIP of 09/512,873) was disclosed in parent application 09/512,873.

### ***Drawings***

7. The formal drawings (9 sheets, 19 total figures) filed by the applicant on 4/24/2002 have been received.
8. The drawings are objected to because Figures 3, 4A, 4B, 11A, 11B, and 11C are blurry and too dark, thereby making the drawings (and what they intend to depict) unclear. A proposed drawing correction or corrected drawings are required in reply

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to the Office Action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

### ***Specification***

9. Applicant is reminded of the proper language and format for an abstract of the disclosure. The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The abstract in the instant application (see page 21 of the specification) is about 175 words in length.
10. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). In this case, the body of the specification does not describe or disclose that the growth rate of the nanostructures in height is at least 5 micrometers per minute, as required by Claim 23. Therefore, the specification does not provide proper antecedent basis for Claim 23, and appropriate correction is required.
11. The disclosure is objected to because of the following informalities:
  - Page 4, line 1: The phrase, "Figs. 4A and 4B shows..." appears to contain a typographical error (i.e., the word "shows" should be "show").
  - Page 13, line 18: The phrase, "the process of claim 1 was performed" appears to contain a typographical error. Specifically, it appears as though the phrase should read, "the process of Example 1 was performed" because

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the discussion of Example 3 indicates conformal alignment of the nanotubes corresponding to Example 1, not straight and curly defect regions that would correspond to the process of Claim 1.

- Page 16: This page of the instant application appears to consist of an additional and unnecessary abstract of the disclosure. To avoid confusion, the applicant is suggested to delete the abstract on page 16 (or the abstract on page 21) so that only a single abstract is present in the instant application.

Appropriate correction is required.

### ***Claim Objections***

12. Claim 6 is objected to because of the following informalities: The claim does not end with a period (".") as required by MPEP 608.01(m). Appropriate correction is required.

### ***Claim Observations***

13. Regarding independent Claim 1, the examiner has reasonably interpreted the term "catalyst metal" to include metals as well as compounds containing the metal (see page 7, lines 3 – 5 of the applicant's specification).

14. Regarding Claim 2, the examiner has reasonably interpreted the term "high frequency" to indicate frequencies of 50 kHz or greater (see page 4, lines 25 – 26 of the specification).

15. Regarding Claims 12 – 14 and 19, the examiner has reasonably interpreted the term “the catalyst metal layer” to be equivalent to “the one or more regions of catalyst metal” recited in independent Claim 1 (from which Claims 12 – 14 and 19 depend).

***Claim Rejections - 35 USC § 102***

16. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

17. Claims 1, 2, 4, 7 – 20, 22, and 23 are rejected under 35 U.S.C. 102(b) as being anticipated by Bower et al. (“Plasma-induced alignment of carbon nanotubes”, Applied Physics Letters, Vol.77, Number 6, pages 830 – 832, August 2000).
18. Regarding independent **Claim 1**, Bower et al. teaches a process for fabricating an article, the process comprising the steps of providing a substrate having a surface including one or more regions of catalyst metal for catalyzing the growth of elongated nanostructures, specifically carbon nanotubes, (Abstract; page 830, Col.2; page 831, Col.1; and Figs. 1(b) and (c)), and growing on the one or more catalyst metal regions at least one elongated nanostructure having at least one substantially straight region and at least one curly defect region, the straight region grown under the influence of an electrical field, and the curly defect region grown with the field off (Abstract; page 830, Col.1, paragraph 2; page 830, Col.2; page 831, Col.1; page



832, Col.1, paragraph 2; page 832, Col.2; and Figs. 3(a) – (c)). Regarding **Claim 2**, Bower et al. also teaches that the straight region is grown by plasma enhanced CVD induced by a microwave (i.e., high frequency) plasma source, and the curly defect region is grown thermally while the plasma source is off (Abstract; page 830, Col.2; page 831, Col.1, paragraph 2; page 832, Col.1, paragraph 2). Regarding **Claim 4**, Bower et al. also teaches that the elongated nanostructure is a nanotube (page 832, Col.1, paragraph 2; Figs. 3(a) – (c)). Regarding **Claim 7**, Bower et al. does not explicitly teach that the nanotube exhibits “electrically rectifying properties”. However, the process of Bower et al. is identical to the applicant’s claimed process, and the nanotube of Bower et al. has the same structure as the applicant’s claimed nanotube (i.e., a plasma CVD grown straight region and a thermally grown curly defect region) (see Figs. 3(a) – (c) and the corresponding description). Since the electrical properties of a nanotube are simply determined by the structure of the nanotube, and the nanotubes of Bower et al. are identical to the applicant’s claimed nanotubes, the nanotubes of Bower et al. would have inherently exhibited electrically rectifying properties. For further support of this position, please see page 832, Col.2 of Bower et al., which discusses the electrical properties of nanotubes having curly junction-type defects. Bower et al. also teaches that the frequency is 2.45 GHz (**Claim 8**) (page 830, Col.2, paragraph 2); the PECVD is performed with a chemistry comprising ammonia and acetylene, wherein the mass flow ratio of acetylene to ammonia is 10 – 30% (**Claims 9 – 11**) (page 830, Col.2, paragraph 2); the substrate comprises silicon and the catalyst metal layer comprises cobalt or iron (**Claims 12**

**and 14)** (page 830, Col.2; page 831, Col.1); the catalyst metal layer is present in a thickness of 0.5 to 200 nm, specifically ~2 nm (**Claim 13**) (page 830, Col.2, paragraph 3); the average nanotube diameter is 10 to 300 nm, specifically about 30 nm (**Claim 15**) (page 830, Col.2, paragraph 3; page 831, Col.1, paragraph 2); the elongated nanostructures have an average length of 0.5 to 30 micrometers, specifically about 22.5 micrometers (i.e., 12 micrometers for the 2 minutes of plasma growth, and an additional 10.5 micrometers for the 70 minutes of thermal growth at 150 nm/min) (**Claim 16**) (page 831, Col.1, paragraph 1; page 832, Col.1, paragraph 2); the catalyst metal layer is a patterned layer, such that the nanostructures form in the pattern (**Claim 19**) (Figs. 1(b) and (c); page 831, Col.1, paragraph 1); the plasma enhanced CVD induces formation of distinct islands of catalyst metal, the nanostructure growth initiating on such islands (**Claim 22**) (Fig. 1(b); page 830, last sentence; page 831, Col.1, paragraph 1); and the growth rate of the nanostructures in height is at least 5 microns per minute, specifically 12 microns in 2 minutes (i.e., a growth rate of 6 microns per minute) (**Claim 23**) (page 831, Col.1, paragraph 1).

Regarding **Claims 17 and 18**, Bower et al. does not explicitly teach that at least a portion of the nanotubes comprise one or more encased catalyst metal particles located proximate the substrate surface. However, Bower et al. does teach that no cobalt (i.e., catalyst) particles are observed at the nanotube tips with SEM (page 831, Col.1, paragraph 1) and that the nanotubes grow through a base-growth mechanism (page 832, Col.1, paragraph 2) from cobalt catalyst islands on the substrate surface (page 831, Col.1, paragraph 1). Based on this information and the

fact that the process conditions of Bower et al. (i.e., type of substrate, type of metal catalyst, specific process gases, plasma excitation frequency, etc.) are identical to the applicant's process conditions, the process of Bower et al. would have inherently produced nanotubes having one or more encased catalyst metal particles located proximate the substrate surface. For further support of this position, see Cui et al. ("Aligned Carbon Nanotubes Via Microwave Plasma Enhanced Chemical Vapor Deposition", July 2000), which shows that the carbon nanotube base-growth mechanism involves encased catalyst metal particles located proximate the substrate surface (Figures 6a – 6f and the corresponding description), and/or Dai et al. (USPN 6,232,706 B1), which shows that the carbon nanotube base-growth mechanism involves the catalyst remaining on the substrate after growth (Col.4, lines 58 – 63). Regarding **Claim 20**, Bower et al. does not explicitly teach that the catalyst metal thickness controls the nanotube diameter. However, Bower et al. does teach that the cobalt catalyst metal is deposited on a substrate to a desired thickness of about 2 nm and then agglomerated into cobalt island nanotube nucleation sites during the temperature ramp-up step (page 830, Col.2, paragraph 3; page 831, Col.1, paragraph 1). In this process, the thickness of the catalyst metal inherently controls the nanotube diameter. For support, see Ren et al. (WO 99/65821 A1), which teaches that the diameter of CVD-grown carbon nanotubes is directly related to the thickness of the catalyst film or nano-dot (page 8, lines 27 – 33; page 9, lines 1 – 4).

***Claim Rejections - 35 USC § 103***

19. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

20. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

21. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bower et al.

22. Regarding **Claim 3**, Bower et al. teaches all the limitations of the claim as set forth above in paragraph 18, except that the defect region is grown by shutting off the plasma source for 1 – 60 seconds. However, Bower et al. does desire to controllably introduce defects (i.e., curly regions) at any selected location along the length of the nanotube by pulsing / turning the plasma on or off (page 832, Col.2). Additionally, by teaching that the growth rate of the curly nanotube region with the plasma turned off is ~150 nm/min (page 832, Col.1, paragraph 2), Bower et al. effectively teaches that

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the length of the curly, defect section of the nanotube depends on the amount of time that the plasma is turned off (i.e., the amount of time that the nanotubes are thermally grown). In other words, Bower et al. shows that the "plasma off" time period is a result / effective variable that determines the length of the curly, defect section of the nanotube. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the "plasma off" time period in the process of Bower et al. as a result / effective variable through routine experimentation in order to grow a nanotube that has a curly, defect region of the length desired by the purveyor in the art. The exact defect region length (and therefore the exact "plasma off" time period) would have been determined by one of ordinary skill in the art based on the desired properties of the carbon nanotube end-product.

23. Claims 5 – 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bower et al. in view of either Crespi et al. (USPN 6,538,262 B1) or Mancevski (US 2001/0023986 A1).

24. Bower et al. teaches all the limitations of **Claims 5 and 6** as set forth above in paragraph 18, except for a method wherein the nanotube comprises, in sequence, a first substantially straight region, a defect region, and a second substantially straight region (Claim 5), or a first substantially straight region, a defect region, a second substantially straight region, a second defect region, and a third substantially straight region (Claim 6). However, Bower et al. does desire to controllably introduce junction-type defects (i.e., curly regions) at any selected location along the length of

the nanotube by pulsing / turning the plasma on or off (page 832, Col.2). Bower et al. teaches that these defects could function as device nodes in various active molecular-level devices (page 832, Col.2). Crespi et al. teaches that nanotube defect junctions provide a wide range of device possibilities, and that arranging defects at various points along the length of a carbon nanotube forms a series of junctions that influence the electronic structure of the tube on either side of each junction (Abstract, Col.8, lines 5 – 8, and Col.13, lines 38 – 56). Mancevski teaches that a carbon nanotube with one defect along its length functions as a diode, and a carbon nanotube with two defects along its length functions as a transistor (paragraphs [0100] – [0103]). In other words, Mancevski teaches that the number of defects along the length of a carbon nanotube influences the electrical properties of the nanotube. It would have been obvious to one of ordinary skill in the art to pulse the plasma of Bower et al. on and off in any manner desired by one of ordinary skill in the art in order to obtain a carbon nanotube having curly defect regions at any desired location along the length of the nanotube (i.e., including either one or two defect regions separating two or three substantially straight regions, respectively, as required by Claims 5 and 6), because Crespi et al. and/or Mancevski teaches that the electrical properties of the resulting carbon nanotube depend on the number and placement of the defect regions. In other words, the exact number and placement of the curly defect regions along the straight nanotube of Bower et al. would have been determined by one of ordinary skill in the art depending on the desired electrical properties and end-use of the nanotube device. Regarding **Claim 7**, the combination

of Bower et al. and either Crespi et al. or Mancevski does not explicitly teach that the nanotube exhibits “electrically rectifying properties”. However, the process of the combination of Bower et al. and either Crespi et al. or Mancevski is identical to the applicant’s claimed process, and the nanotube of the combination of Bower et al. and either Crespi et al. or Mancevski has the same structure as the applicant’s claimed nanotube (i.e., straight region(s) separated by curly defect region(s)). Since the electrical properties of a nanotube are simply determined by the structure of the nanotube, the nanotubes of the combination of Bower et al. and either Crespi et al. or Mancevski would have inherently exhibited electrically rectifying properties, as claimed by the applicant.

25. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bower et al. in view of Ren et al. (WO 99/65821 A1).

26. Bower et al. teaches all the limitations of **Claim 21** as set forth above in paragraph 18, except for a method wherein the plasma enhanced CVD process exhibits stages of growth, stability, and etch as to nanotube length. However, Bower et al. is clearly concerned with the length of the deposited nanotubes (page 830, Col.2, paragraph 3; page 831, Col.1, paragraph 1). Ren et al. teaches that the length of carbon nanotubes grown by CVD can be controlled by the growth duration, and that the growth time depends on the requirement of nanotube length (page 9, lines 19 – 22). Typical growth times are between 1 and 10 minutes (page 9, line 20) but can extend up to 5 hours (page 9, line 21). In other words, Ren et al. teaches that the carbon

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nanotube growth time is a result / effective variable that determines the length of the nanotube. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the growth time in the process of Bower et al. to be within the typical range (e.g., 1 to 10 minutes, up to 5 hours) taught by Ren et al. as a result / effective variable through routine experimentation, depending on the desired length of the nanotube(s). Since this range of nanotube growth times encompasses time periods longer than the applicant's disclosed growth time which yields stages of growth, stability, and etch (see applicant's Figure 6), and the process conditions of Bower et al. are identical to the applicant's claimed and disclosed process conditions, the process of the combination of Bower et al. and Ren et al. (i.e., using growth times of up to 5 hours) would have inherently exhibited stages of growth, stability, and etch as to nanotube length.

27. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bower et al. in view of either Lee et al. (USPN 6,673,392 B2) or Gevelber et al. (USPN 6,162,488).

28. Bower et al. teaches all the limitations of **Claim 24** as set forth above in paragraph 18, except for a process wherein the growth rate per micrometer height is at least  $0.01 \times 10^6 \text{ cm}^2$  per hour. Specifically, Bower et al. is silent regarding the nanotube surface area growth rate. However, Lee et al. teaches that by growing carbon nanotubes on several substrates simultaneously, the productivity of the process is increased (Col.5, lines 33 – 41). Gevelber et al. teaches that a primary economic



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process objective in a CVD process is process throughput, and the throughput can be maximized by simultaneous deposition on multiple substrates (Col.17, lines 66 – 67, Col.18, lines 1 – 6). In light of the teachings of either Lee et al. or Gevelber et al., it would have been obvious to one of ordinary skill in the art to advantageously maximize the productivity of the process of Bower et al. by simultaneously performing the carbon nanotube growth process on any number of substrates required to achieve the desired process throughput. By doing so, the surface area growth rate would also have been maximized (i.e., due to the multiple substrates) to, for example, a value greater than  $0.01 \times 10^6 \text{ cm}^2$  per hour.

### ***Conclusion***

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Hafner et al. (US 2002/0112814 A1) teaches using CVD to grow large diameter carbon nanotubes consisting of straight segments mixed with kinked and bending segments (paragraph [0051]). Merkulov et al. (US 2003/0148577 A1) teaches growing carbon nanotubes by CVD under the influence of an electric field and changing a direction associated with the field during the deposition process in order to obtain bent nanotubes.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D Markham whose telephone number is (571) 272-1422. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.


If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (571) 272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



WDM

Wesley D Markham  
Examiner  
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**SHRIVE P. BECK**  
**SUPERVISORY PATENT EXAMINER**  
**TECHNOLOGY CENTER 1700**